Acoustic-Trawl-Method Surveys

Estimating CPS biomasses, spatial and length distributions, natural mortalities, and their uncertainties

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Overview – ATM Sampling, Analyses, and Results

- ATM Sampling
  - Equipment
  - Sampling Design
  - Acoustic Sampling
  - Trawl Sampling
- ATM Analyses
  - Echo classification
  - Apportioning to Species
  - Converting to Fish Densities
  - Converting to Biomasses
  - Estimating Sampling Errors
- ATM Results
  - CPS Distributions and abundances
  - Length Distributions and Natural Mortalities
  - Data management

- ATM Strengths
  - Direct estimates of CPS populations
  - Estimates for multiple species
- ATM Challenges
  - Sample Entire Stocks
  - Sample Near Shore
  - Sample Near Sea-Surface
  - Better Estimate Species Proportions & Sizes
- ATM Strategies for Improvement
  - Characterize Habitats for Multiple Stocks
  - Use Scanning, Multi-beam and Imaging Sonars
  - Characterize Trawl Performance
  - Sample Optically Underway
Equipment

- Simrad EK60 Echosounders
- Nordic 264 Trawl
Sampling Design

- Six Regional Fisheries
  - Ensenada, Mexico
  - San Pedro, California, USA
  - Monterey, California, USA
  - Oregon, USA
  - Washington, USA
  - Vancouver Island, Canada

- Seasonal Sardine Distribution
  - Spring – off central and so. CA
  - Summer – off central CA, OR, WA, and Vancouver Island

Sampling Design

- Potential habitat (optimal+good)
- Eggs (positive samples red)
- Positives contiguous
  - $11.5 \leq \text{SST} \leq 15.5 \, ^\circ\text{C}$ &
  - $0.18 \leq \text{CHL} \leq 3.2 \, \text{mg/m}^3$
- Inshore boundary
  - Fresh upwelling
  - $\text{SST} < 11.5$ & $\text{CHL} > 3.2$
- Offshore boundary
  - Oceanic water
  - $\text{SST} > 15.5$ & $\text{CHL} < 0.18$

Sampling Design

ATM Sampling

- Transects
  - 40 – 80 n.mi. spacing
  - Nominally 10 kt speed
  - Nighttime stations
- Acoustics
  - Simrad EK60s
  - 18, 38, 70, 120, 200 kHz
  - 1 ms pulses
  - Optimized range (to 750 m)
  - Optimized transmit interval
- Trawls
  - Nordic 264
  - Surface
  - Nighttime, nominally 3 day⁻¹

ATM Analysis – Apportioning to Species

CPS backscatter

CPS proportion

Sardine density
ATM Results – Estimated Distributions

ATM Results – Estimated Biomass and Error

- Biomass estimated by multiplying the stratum mean density and area
- Random sampling error estimated by bootstrap of transect mean densities

ATM Results – Length Distributions

- Biomass-weighted lengths
- Observed cohorts
  - 2009-2010 during 2011–2012

Data Management

- Data Processing and Telemetry
  - Data processed shipboard and ashore
  - Data and products telemetered via satellite
  - Reports drafted by the end of each survey
- Data Archive
  - Local data server
  - Managed by researchers
  - Backed-up by IT
- Publications
  - Peer-reviewed journals
  - NOAA Technical Memoranda
ATM Strengths

“One of the most urgent needs ... is in our capability to make timely, synoptic, species specific stock assessments over wide geographic areas...underwater acoustics [is] the only recourse in conducting more than a surface examination of marine fish resources.”

- D.V. Holliday, 1972

“... acoustic-midwater trawl surveys are the most effective means for directly assessing the status of northern anchovies [including] ...distribution and abundance... availability, seasonal movements, schooling behavior, and vulnerability to harvest methods...”

- K. F. Mais, 1974

• Direct estimates for multiple species of fish and zooplankton

ATM – Challenges

- Sample Entire Stocks
- Sample Near Shore
  - Currently > 40 m seabed depth and 2 km from shore
- Sample Near Sea-Surface
  - Currently > 10 m water depth
- Better Estimate Species Proportions and Fish Sizes
  - Currently 1-3 nighttime trawls in areas with daytime CPS echoes

ATM Strategies for Improvement – Habitat Characterization

- Seasonal dynamics of the potential habitat for the northern stock of sardine
- Temperature regimes for the northern and southern stocks of sardine
- Apportion landings to different stocks
- Cooperatively sample transboundary stocks

ATM Strategies for Improvement – Optical Sampling

- Monitor Trawl Performance
  - Trawl-mounted cameras
  - Monitor trawl shape and function
  - Observe fish behaviors
  - Quantify size selectivity
- Sample optically underway
ATM Strategies for Improvement – Acoustic Imaging

• Use Scanning, Multi-beam and Imaging Sonars

Simultaneous 3-D imaging of fish and seabed
ATM Strategies for Improvement – Automation and Enhanced Nearshore Sampling

Automate data collection, archive, processing, reporting, and dissemination

Increase ATM sampling nearshore, particularly in fishing regions